INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue5)
Available online at www.ijariit.com

Power Quality Improvement and Harmonic Mitigation by Using D-Statcom

Soujanya Mekala
JNTUH College of Engineering Jagtial, Telangana
souju10@gmail.com

Abstract: The main impact in the power distribution system is the quality of power, which causes more distortion in the source due to using nonlinear load. The main cause for distortion is harmonics, and interharmonics. Thus it is necessary to control the harmonics to improve the power quality of the system. There are number of control techniques to improve the power quality with the FACTS devices.

In this paper performance of Distribution Static Compensator (D-STATCOM) for Power Quality improvement has been studied. The simulation is done in MATLAB/SIMULINK environment.

Keywords: Power Quality, Harmonics, Linear Load, Non-Linear Load, D-STATCOM.

I. INTRODUCTION

The power quality is very broad by nature. It covers all aspects of power system engineering, from transmission and distribution level analyses to end-user problems. Therefore, electric power quality has become the concern of utilities, end users, architects, and civil engineers as well as manufacturers. These professionals must work together in developing solutions to power quality problems: An electric distribution system is part of an electric system between the bulk power source or sources and the consumer's service switches. The bulk power sources are located in or near the load area to be served by the distribution system and may be either generating stations or power substations supplied over transmission lines. One of the most common power quality problems today are voltage sag, voltage swell and harmonic distortion. Voltage sag is a decrease of the normal voltage level between 10% and 90% of the nominal rms voltage at the power frequency, for durations of 0.5 cycle to 1 minute. Causes for it, faults on the transmission or distribution network, faults in consumer insulation, connection of heavy loads and start-up motor. Voltage swell is a momentary increase of the voltage, at the power frequency, outside the normal tolerances, with duration of more than one cycle and typically less than a few seconds. And cause for it start/stop of heavy loads, badly dimensioned power sources, badly regulated transformers. And harmonic distortions are voltage and current wave forms assume non-sinusoidal shape. The waveform corresponds to the sum of different sine-waves with different magnitude and phase, having frequencies that are multiples of power-system.

2. D-STATCOM

The Distributed Static Compensator (D-STATCOM) is used in distribution system for reactive power compensation and to reduce harmonics. D-STATCOM is connected in parallel with transmission lines. For example if we are transmitting 1000 kv through transmission lines and at receiver end we are receiving 800 kv that means losses are there. These may be reactive power, voltage sag and harmonics. So we use D-STATCOM for reactive power compensation and also mitigate the voltage fluctuations.

A D-STATCOM consists of a two-level VSC, a dc energy storage device, controller and a coupling transformer connected in the shunt to distribution network. D-STATCOM or Distribution Static compensator is a power electronic device using force commutated devices like IGBT, GTO etc.to control the reactive power flow through a power network and thereby increasing the stability of power D-STATCOM is a shunt device i.e. it is connected in shunt with the line. The term synchronous in statcom mean that it can either absorb or generate reactive power in synchronization with the demand to stabilize the voltage of the power network. Schematic diagram of D-statcom as shown in below fig.

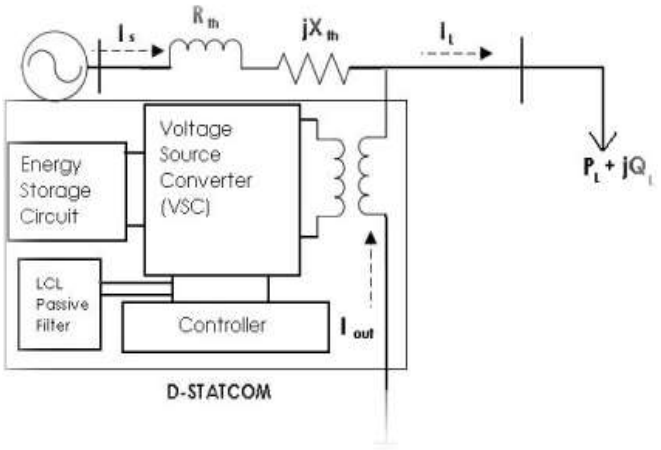


Fig. 2.1 Schematic Diagram of D-STATCOM

3. VOLATAGE SOURCE INVERTER (VSC)

Voltage source converters are widely used in adjustable speed drives, but can also used to mitigate voltage dips or sags. The VSC is used to either completely replace the voltage or to inject the missing voltage. The missing voltage is the difference between normal voltage and actual. The converter is normally based on some kind of energy storage which will supply the converter with a DC voltage.

A voltage source converter is a power electronic device, which can generate a sinusoidal voltage with any required magnitude, frequency and phase angle. Normally the VSC not only used for voltage swag/swell mitigation but also for other power quality issues. E.g. flicker and harmonics.

4. ENERGY STORED CIRCUIT

A diagram for energy stored circuit as shown in below figure.

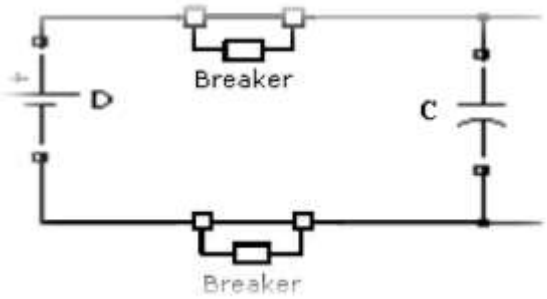


Fig.4.1. Energy stored circuit

From fig 4.1 DC source is connected in parallel with the DC capacitor. It carries the input ripple current of the converter and it is the main reactive energy storage element. This DC capacitor could charge by a battery source or could br recharged by the converter itself.

5. CONTROL STRATEGY

D-STATCOM has been used extensively for reactive power compensation, load balancing and harmonic mitigation in the distribution system. The objective of the compensating scheme is to supply the oscillating component of power such that the dc component can be supplied by the source. The performance of D-STATCOM depends on the control algorithm used for extraction of reference current components.

6. PASSIVE L-C-L Filter

A low passive lcl filter normally used for harmonic suppression. A low-pass **passive LCL-filter** is usually used to interconnect a power electronic converter to a grid system. (This can also be done by using a **passive** L-**filter**.) Nevertheless, designing an **LCL-filter** is not simple because of high compensating bandwidth and variable frequency modulations involved in active **filters**.

7. METHODOLOGY

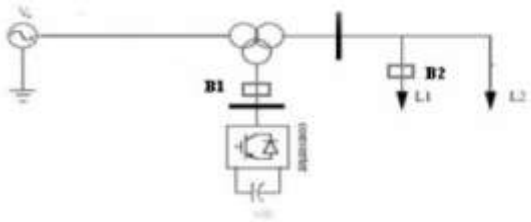


Fig 7.1 Single line diagram for test system.

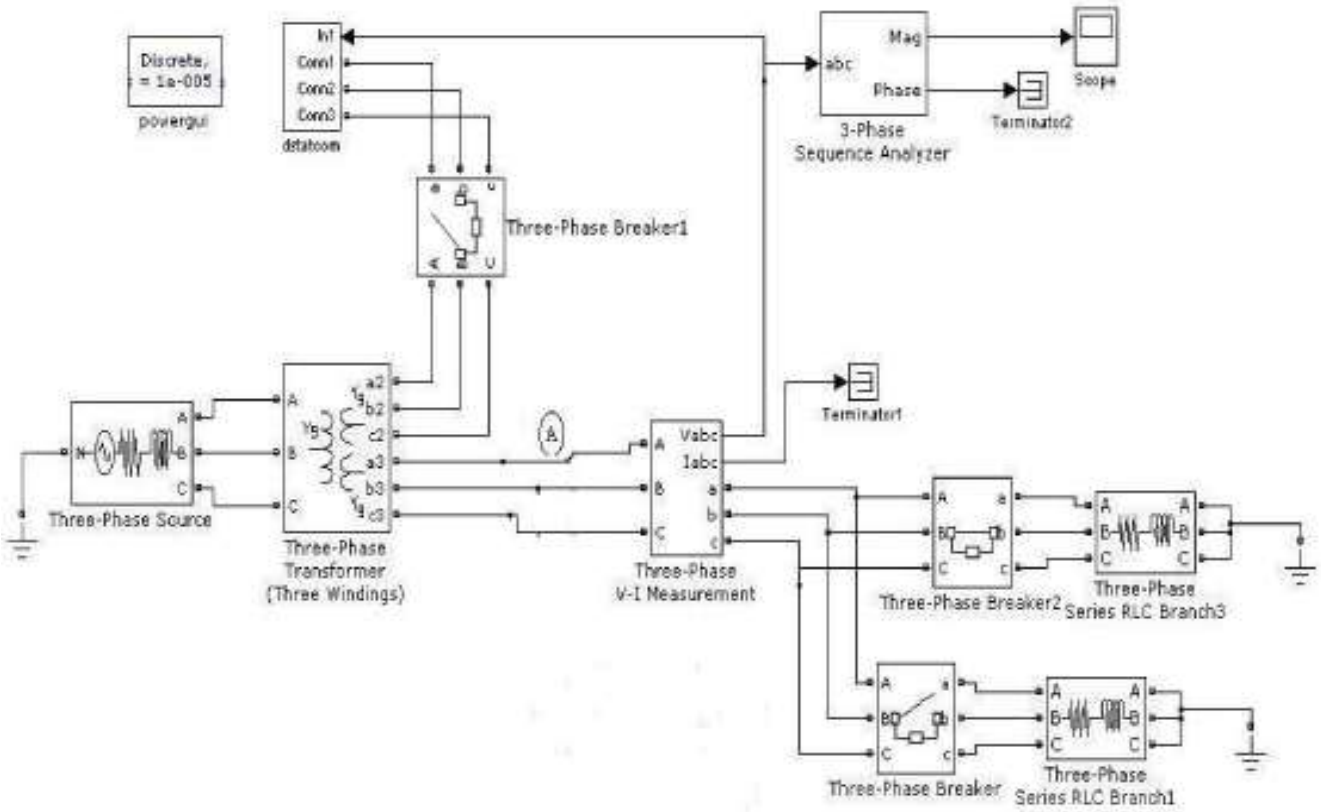
To enhance the performance of distribution system, D-STATCOM was connected to the distribution system. D-STATCOM was designed using MATLAB Simulink version R2009b. The test system shown in fig 7.1 comprises a 230kV, 50Hz transmission system, represented by a venin equivalent, feeding into the primary side of 3-winding transformer connected in Y/Y/Y, 230/11/11 kV. A varying load is connected to 11 kV, secondary side of transformer.

A two level D-STATCOM is connected to the 11 kV tertiary winding to provide instantaneous voltage support at the load point. A 750 μF capacitor on the DC side provides the D-STATCOM energy storage capabilities.

8. SIMULINK MODEL AND SIMULATION RESULTS

8.1 simulation results of voltage sag

In this case D-STATCOM is not connected and a single line to ground fall is applied at a point 'A' with a fault resistance of 1.06 Ω. The voltage sag is shown in fig.8.1.with a time period of 500ms-900ms.



.

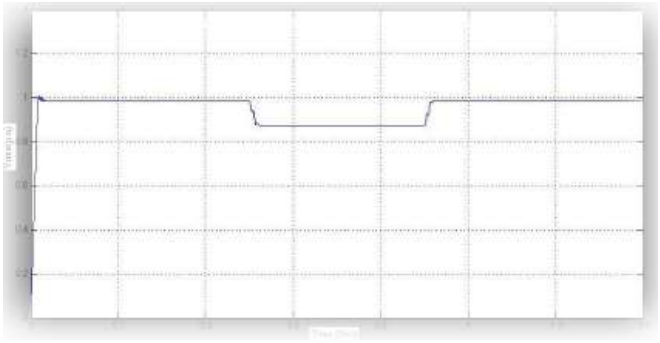


Fig.8.1.Voltage Vrms at the load point without DSTATCOM

From the fig.8.2. The voltage sag is mitigated with an energy storage of 18.2 kV, when the DSTATCOM is connected to the system.

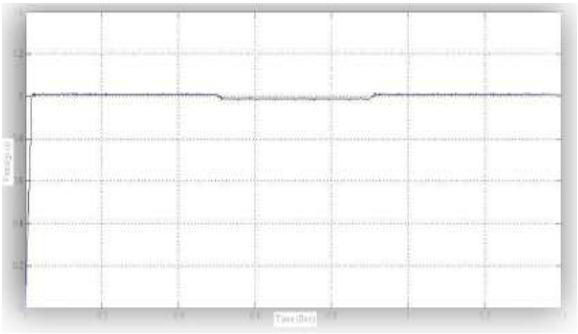


Fig.8.2.Voltage Vrms at the load point with DSTATCOM: with energy storage of 18.2 kV.

8.2 Simulation results of Voltage swell

In this case, D-STATCOM is not connected
and a capacitive load is applied at a point 'A' the voltage swell is shown in fig.8.3. With a time period of 500ms-900ms.
As a simulation is carried out with a D-STATCOM connection as shown in the figure 8.4. The voltage swell is mitigated with energy storage of 13.2kV.

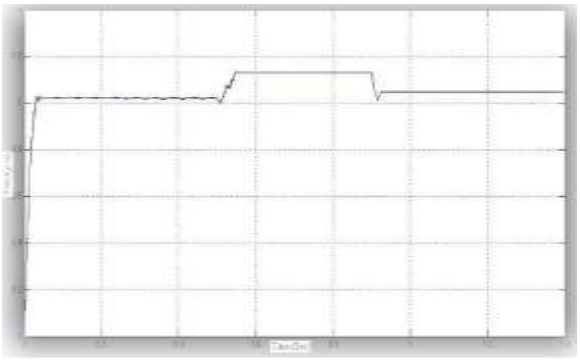


Fig. 8.3.Voltage Vrms at the load point without DSTATCOM

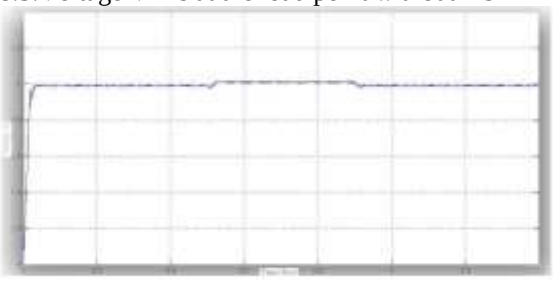


Fig.8.4. Voltage Vrms at the load point with DSTATCOM: with Energy storage of 13.2 kV.

CONCLUSION

Hence this paper concludes that D-STATCOM is a promising device in order to improve the power quality and harmonic suppression. Here by using D-STATCOM sag of 13%, interruptions of 25% and swell of 11% conditions are mitigated.

REFERENCES

1. R.Mienski R Pawelek and I.Wassiak., "Shunt compensation for Power Quality Improvement using a STATCOM controlle: Modelling and simulation", IEEE Proce., Vol. 151, No 2, March 2004.
2. Haque, M.H,"Compensations of distribution system voltage sag by DVR and D-STATCOM", Power tech proceedings, 2001 IEEE Porto, Vol. 1,pp.10-13, September. 2001
3. Abhayrajsinh J Rana, Indrajith N.Trivedi : "Application of D-STATCOM for power quality improvement in distribution line", 2016 IEEE.
4. Huili, Hao Zhang; Fei Ma; "Modelling, control and simulation of grid connector PV system with D-STATCOM", 2014 IEEE.
5. Shaik Mohammed Mukassir, Gulam amer
"Power Quality Improvement using a novels D-STATCOM control scheme for linear and non linear loads", 2016 IEEE..
6. G. Yaleinkaya, M.H.J. Bollen, P.A. Crossley, "Characterization of voltage sags in industrial distribution systems", IEEE transactions on industry applications, Vol 34, no 4, July/August, pp. 682-688, 1999.

